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VOLUME VII NUMBER 6

MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

Contents

The Taxonomy and Cytology of the Subgenus Gormania of Sedum, *Robert T. Clausen and Charles H. Uhl* 161

J. W. Stacey, Caricologist, *John Thomas Howell* 181

Dermatitis and Photosensitization Produced by Ptelea angustifolia, *W. C. Muenscher and Babette I. Brown* 184

On the Shoot Apex of Chlorogalum pomeridianum (DC.) Kunth, *Clarence Sterling* 188

Notes and News: *Oenothera brachycarpa in Texas* (V. L. Cory); *News* . . . 192

Published at North Queen Street and McGovern Avenue,
Lancaster, Pennsylvania

April, 1944

MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

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Entered as second-class matter October 1, 1935, at the post office at Lancaster, Pa., under the act of March 3, 1879.

Established 1916. Published quarterly. Subscription Price $2.50 per year. Completed volumes I to V inclusive, $25.00; each volume $5.00; single numbers $0.75.

Papers up to 15 or 20 pages are acceptable. Longer contributions may be accepted if the excess costs of printing and illustration are borne by the contributor. Range extensions and similar notes will be published in condensed form with a suitable title under the general heading "Notes and News." Articles may be submitted to any member of the editorial board. Manuscripts may be included in the forthcoming issue provided that the contributor pay the cost of the pages added to the issue to accommodate his article. Reprints of any article are furnished at a cost of 4 pages, 50 copies $4.10; 100 copies $4.50; additional 100's $0.85; 8 pages, 50 copies $5.95; 100 copies $6.60; additional 100's $1.30; 16 pages, 50 copies $8.35; 100 copies $9.35; additional 100's $2.00. Covers, 50 for $2.75; additional covers at $1.65 per hundred. Reprints should be ordered when proofs are returned.

Published at North Queen Street and McGovern Avenue, Lancaster, Pennsylvania, for the

CALIFORNIA BOTANICAL SOCIETY, INC.

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Annual membership dues of the California Botanical Society are $2.50, $2.00 of which is for a year's subscription to Madroño. Dues should be remitted to the Treasurer. General correspondence and applications for membership should be addressed to the Secretary.

THE TAXONOMY AND CYTOLOGY OF THE SUBGENUS GORMANIA OF SEDUM

Robert T. Clausen and Charles H. Uhl

Introduction

The species of *Sedum* comprising the subgenus *Gormania* seem to constitute a natural group in biological relationship. In geographical distribution, they are all restricted to the Pacific Mountain System of Western North America. Some of the principal points of this discussion appeared in a brief abstract in the American Journal of Botany (4). The detailed evidence for the statements made there are herein presented.

Historically, the species which we assign to the subgenus *Gormania* have had a troubled nomenclatural career. They have been referred variously to *Cotyledon, Echeveria, Gormania* and *Sedum.* The senior author (3) has already given his reasons for regarding this group of species as a subgenus of *Sedum.* Continued study and additional evidence have not altered this point of view. *Sedum spathulifolium* clearly belongs to the *Gormania* series, yet it is too close to typical *Sedum* to warrant generic segregation. Characters seem lacking by which it might be segregated from *Sedum* on a generic basis. Our data clearly indicate the alignment of *S. spathulifolium* with the true Gormaniae, yet it has petals distinct to the base, a detail also emphasized by Britton and Rose (2). *S. spathulifolium* affords a direct living connection between typical *Sedum* and the extreme types of section *Eugormania.* The separate petals of *S. spathulifolium* and the closely related *S. Purdyi,* usually regarded as an indication of morphological primitiveness, seem to strengthen the idea that these two species are less advanced phylogenetically than the other species of *Gormania.* They may be regarded as constituting a separate section from which *Eugormania* probably has evolved. It is interesting to note that *S. spathulifolium,* supposedly the most primitive species in the subgenus, is the most widely distributed; also, the other species all occur within its distributional area.

Three authors have rather recently accounted for the species which we place in subgenus *Gormania.* A comparison is interesting to show the differences in interpretation. Praeger (12), though considering only cultivated species, treated four of the binomials which we refer to subgenus *Gormania.* He assigned all of these to the section *"Seda Genuina,"* group *Spathulifolia,* in which he also placed two other species. The six binomials, our disposition of them when we do not regard them as valid species, and the chromosome number for each, follow:

Madroño, Vol. 7, pp. 161–192. April 20, 1944.

S. spathulifolium Hooker — $n = 15$, $2n = 30$
S. yosemitense Britton = a subspecies of *S. spathulifolium* — $n = 15$
S. rubroglaucum Praeger = *S. obtusatum* subsp. *typicum*
S. Hallii (Britton) Praeger = *S. obtusatum* subsp. *typicum* — $2n = 30$
S. oreganum Nuttall — $n = 12$
S. divergens S. Watson — $2n =$?16

Berger (1) referred the species of *Gormania,* along with others, to two different groups of section *"Seda Genuina."* Below are listed all the species which he included in these groups, with those starred which we place in the subgenus *Gormania.*

Group 5. *Americana*
S. longipes Rose
S. filiferum S. Watson
S. Lumholtzii Robinson & Fernald
S. puberulum S. Watson = *S. Griffithsii* Rose
S. Wootonii Britton = *S. Cockerellii* Britton — $n = 16$
S. Griffithsii Rose — $n = 14, 29$
S. Wrightii A. Gray — $n = 12, 36$
S. Nevii A. Gray — $n = 6$
S. Nevii A. Gray var. *Beyrichianum* (Masters) Praeger = *S. Beyrichianum* Masters — $n = 14, 28$
S. madrense S. Watson
**S. californicum* Britton = *S. spathulifolium* Hook.
S. bellum Rose
S. versadense Thompson
**S. Burnhamii* (Britton) Berger = *S. obtusatum* Gray subsp. *typicum* — $2n = 30$
**S. laxum* (Britton) Berger = *S. laxum* subsp. *typicum* — $2n = 30$
**S. sanhedrinum* Berger = *S. laxum* subsp. *retusum*
**S. Eastwoodiae* (Britton) Berger = *S. laxum* subsp. *retusum* — $2n = 30$

Group 23. *Rosulata*
**S. spathulifolium* Hooker — $n = 15$, $2n = 30$
**S. pruinosum* Britton = a subspecies of *S. spathulifolium* — $n = 15$, $2n = 30$
**S. yosemitense* Britton = a subspecies of *S. spathulifolium* — $n = 15$
S. Leibergii Britton
**S. Woodii* Britton = typical *S. spathulifolium* — $n = 15$
**S. Watsonii* (Britton) Berger = *S. oregonense* (Watson) Peck — $2n = 90$
**S. obtusatum* A. Gray = *S. obtusatum* subsp. *typicum* — $2n = 30$
**S. Hallii* (Britton) Praeger = *S. obtusatum* subsp. *typicum* — $2n = 30$

S. debile S. Watson — $2n = 14$–18
S. oreganum Nutt. — $n = 12$

The various chromosome numbers which appear in the above lists are explained and discussed in a recent article in Brittonia (5).

Fröderström (8) recognized *Gormania* as a separate genus, including in it *G. obtusata, G. Watsoni, G. anomala* and *G. rubroglauca.* He placed in two different groups of *Sedum,* under *"Americana Kyphocarpia,"* other of the names which we refer to *Gormania.* These are starred in the following lists.

Group *Ternatum*
- *S. ternatum* Michx. — $2n = 16, 24, 32, 48$
- *S. Nevii* A. Gray — $n = 6$
- **S. californicum* Britton = a subspecies of *S. spathulifolium*
- *S. bellum* Rose

Group *Spathulifolium*
- **S. spathulifolium* Hooker — $n = 15$
- **S. pruinosum* Britton = a subspecies of *S. spathulifolium* — $n = 15$
- *S. Leibergii* Britton
- **S. Woodii* Britton = typical *S. spathulifolium* — $n = 15$
- **S. yosemitense* Britton = a subspecies of *S. spathulifolium* — $n = 15$

Our own arrangement follows:

Section 1. *Rosulata*
- *S. spathulifolium* (including *S. anomalum, S. californicum, S. pruinosum, S. Woodii* and *S. yosemitense*) — $n = 15, 2n = 30$
- *S. Purdyi* — $n = 15$

Section 2. *Eugormania*
- *S. obtusatum* — $n = 15, 2n = 30$
- *S. oregonense* — $2n = 90$
- *S. laxum* — $n = 15, 2n = 30$
- *S. Moranii* — $2n = 30$

Sedum oreganum, for which the senior author (3) created the section *Oreganica,* clearly does not belong to the *Gormania* series. In habit, it is at once different, without prominent basal rosettes of leaves. Also, the petals are straight, not erect below and then spreading. Further, the chromosomes, though comparable in size with those of the species of subgenus *Gormania,* exhibit a greater range in size among the members of the same complement. Also, the haploid number is 12. Probably *S. oreganum* should be dropped from subgenus *Gormania* and referred to another subgenus of *Sedum.* Our data for this species are based on various living plants which originated in the state of Washington. The chromosome counts were made from collections of Professor W. C. Muenscher (*7923* and *7929*).

In the present work, the taxonomic study is by R. T. Clausen, the cytological investigation by C. H. Uhl. The collecting of plants for this study was made possible by grants from the Penrose Fund of the American Philosophical Society and the Trustee-Faculty Committee on Research of Cornell University. The cytological work was made possible by the grant from the Trustee-Faculty Committee. The plants in cultivation have been grown and maintained through the courtesy of the Department of Floriculture of Cornell University.

METHODS AND MATERIALS

We continue to employ the category of subspecies for the major morphological races of species which are geographically correlated because no really valid argument has yet been advanced against such usage. The criticisms by Fosberg (7) and Weatherby (13) fail to cope with the problem of horticultural varieties. Horticulturists continue to designate minor genetical variations of species, not geographically correlated, as varieties, ignoring the arguments of Fernald, Weatherby and Fosberg, who presumably would designate such variants as forms. For examples of the use of variety by tradesmen and horticulturists, see the 1943 catalog of W. Atlee Burpee Co. (pages 26, 27 *et al*) or the recent bulletin on grapes by Magoon and Snyder (11). The International Rules of Nomenclature do not outlaw subspecies for the groups which we so designate. On the other hand, a convincing argument can be constructed the other way. Most botanical and horticultural varieties are very minor genetic variations. These variations often are of great economic or horticultural significance, but phylogenetically are not yet important enough to be regarded either as species or subspecies. These should, in our opinion, be designated as varieties. They are numerous, really too numerous to warrant assigning botanical names to each, yet many have been named. Forms are the phenotypic variations of the same genotype. In *Sedum* they can frequently be produced by giving the plants more water than normal or by placing them in dense shade. They are usually physiological in origin and are best designated merely by descriptive vernacular terms.

The living plants which are the real basis for our classification were obtained for the most part in the summer of 1940 when Mr. Harold Trapido and the senior author collected extensively on the Pacific slope. Details of distribution have been obtained from a study of specimens in various herbaria. In the citations, names of these are abbreviated as: (BH) Bailey Hortorium, Ithaca, New York; (CAS) California Academy of Sciences, San Francisco; (CLOK) Clokey Herbarium at the University of California, Berkeley; (CU) Cornell University, Ithaca, New York; (DS) Dudley Herbarium, Stanford University, California; (FM) Field Museum of Natural History, Chicago Illinois; (NY) New

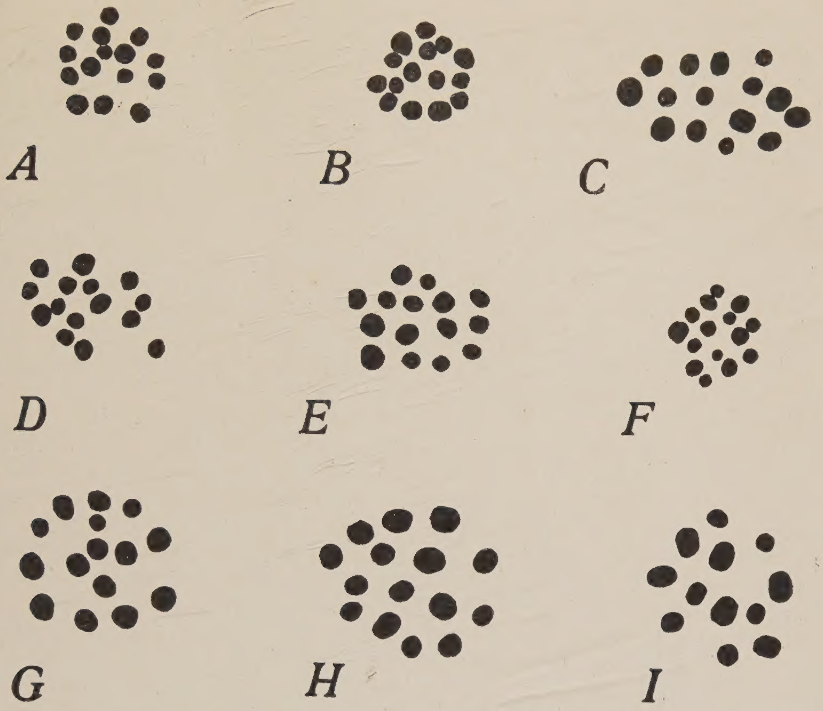

FIG. 1. Chromosome complements. *A, Sedum spathulifolium* subsp. *typicum,* from Josephine County, Oregon (*C5010*); fixed in craf, $n = 15$. *B, S. s.* subsp. *typicum,* from Lake County, California (*C4925*); fixed in craf, $n = 15$. *C, S. s.* subsp. *pruinosum,* from south of Crescent City, Del Norte County, California (*C4937*), $n = 15$. *D, S. s.* subsp. *anomalum,* from San Bernardino Mountains, California (*C4748*), $n = 15$. *E, S. s.* subsp. *anomalum,* from Yosemite National Park, California (*C4802*); second meiotic metaphase, $n = 15$. *F, S. Purdyi,* from the canyon of Canyon Creek, Siskiyou County, California (*C4983*); fixed in craf, $n = 15$. *G, S. laxum* subsp. *retusum,* from Mendocino County, California (*UC28.3*), $n = 15$. *H, S. laxum* subsp. *typicum,* from Waldo, Oregon (*C5018*), $n = 15$. *I, S. oreganum,* from Lummi Island, Whatcom County, Washington (*WCM7925*), $n = 12$. Unless otherwise noted, all figures are first meiotic metaphases and fixation was in Carnoy's solution. All drawings are ×3320.

York Botanical Garden, New York, New York; (ORE) University of Oregon, Eugene; (POM) Pomona College, Claremont, California; (UC) University of California, Berkeley; (US) United States National Herbarium, Washington, D. C. We wish to thank the curators at each of these institutions for making their specimens available for study.

The counts of chromosomes are from meiotic material. Most of the young flowers were fixed in Carnoy's fluid (6 parts chloroform, 3 parts absolute alcohol, and 1 part acetic acid), smeared, and stained in aceto-carmine. Some were fixed in craf, embedded, sectioned, and stained in crystal violet. All preparations were examined with a Spencer microscope with 95× fluorite objective, N.A. 1.25. Drawings were made with a camera lucida, all × 3320. The chromosomes, as well as metaphase plates, of material fixed in craf and stained in crystal violet were consistently smaller than those of material fixed in Carnoy's. This must be remembered in examining the figures. For purposes of comparison, the drawings, with one exception, are all of first meiotic metaphases.

CYTOLOGY

The details regarding chromosome number and morphology are reported under the various species and subspecies. Great similarity prevails throughout the whole subgenus. All species are $n = 15$, with the exception of *S. oregonense,* for which a $2n$ number of about 90 has been determined by Hollingshead (9). Comparison of the chromosome complements of eleven collections of *S. spathulifolium,* one of *S. Purdyi,* one of *S. laxum* subsp. *typicum* and one of *S. laxum* subsp. *retusum* indicate that these species can not be distinguished by their chromosomes. The chromosome complements are very similar, indicating close relationship between the two species of the section *Rosulata* and species of the section *Eugormania. Sedum oreganum,* with an n number of 12, seems remote from the species of *Gormania* and, as has already been suggested, should be dropped from this subgenus. Text figure 1 shows the chromosome complements in the various subspecies of *S. spathulifolium* and in *S. Purdyi, S. laxum* and *S. oreganum.*

SYSTEMATIC ACCOUNT

Gormania, as a subgenus, had its beginning in 1942. The key to the sections of the subgenus, in a recent paper by the senior author (3, pp. 28, 29), may now be emended as follows:

A. Petals separate to their bases, erect for about one-tenth of length, then widely spreading; rosettes with the leaves fleshy, but not leathery; inflorescence a 3-parted cyme, sometimes compound .... 1. Section *Rosulata*
AA. Petals connivent or united for one-fourth or more of length, erect below, divergent above; rosettes with the leaves thick and leathery; inflorescence a paniculate cyme .... 2. Section *Eugormania*

Section **Rosulata** (Berger) Clausen et Uhl, stat. nov. Group *Rosulata* Berger, in Engl. & Prantl, Nat. Pflanzenfam. ed. 2, 18a: 457. 1930. Section *Rosulata* Clausen and Uhl, *nomen nudum,* Bull. Torrey Bot. Club 69: 27. 1942. Type species: *S. spathulifolium* Hooker.

Petals separate throughout their length, erect below for about one-tenth their length, then widely spreading; leaves arranged in prominent rosettes borne on creeping stems which give rise to numerous secondary stems, likewise rosette-bearing; plants frequently producing large patches or mats which may spread for many years by vegetative means.

Key to the Species of Section Rosulata

A. Rosettes loose, not densely compressed; leaves of rosettes loosely spreading, not closely compacted, minutely crenulate and papillose	1. *Sedum spathulifolium*
AA. Rosettes densely compressed with the leaves closely compacted (pressed close together) and prominently papillate on margins	2. *Sedum Purdyi*

1. Sedum spathulifolium Hooker

Perennial; sterile stems 1–3 mm. in diameter, 1–8.5 cm. long, white to pink or red, procumbent or creeping; leaves in prominent rosettes, usually spatulate, blunt or slightly emarginate, crenulate on margins, 0.3–3.2 cm. long, 2–14 mm. wide, 1–3 mm. thick, glaucous or pruinose or glabrous and dark- or yellow-green, sometimes suffused with red or bronze; primary stems usually with secondary offsets below rosettes and these sometimes with tertiary offsets; sterile shoots usually naked except for the rosette at the apex, but sometimes leafy throughout with alternate oblong-spatulate leaves, 0.5–1.5 cm. long; floral stems erect or decumbent, 5–30 cm. high, 1–4 mm. thick below inflorescence, with the leaves alternate, spatulate, oblong-spatulate, or elliptic-oblong, reduced downwards, 0.6–2.0 cm. long, 3–8 mm. wide; inflorescence a simple or compound three-parted cyme of 12–51 flowers, with a central flower; floral bracts oblong-spatulate, 4–11 mm. long; flowers sessile or short-stalked on pedicels 1–4 mm. long, usually 5-merous, 0.7–1.7 cm. in diameter; sepals lanceolate or ovate-lanceolate, connate below, 2–4 mm. long; petals lanceolate, acute, concave, 5–8 mm. long, erect below for 2–3 mm., then widely spreading, canary-yellow, rarely orange or white; stamens 4–5 mm. long, yellow; nectar scales 0.5 mm. long, 0.2 mm. wide, transversely oblong, deep yellow; pistils yellow-green, erect or divergent, but not widely spreading, 4–7 mm. long, with slender styles, 1.2–3 mm. long; seeds pyriform, reddish-brown, 1 mm. long.

This is at once the commonest and most widely distributed species of the subgenus *Gormania*. It may be recognized by its creeping habit, its abundant rosettes of loosely arranged fleshy leaves and the three-parted cymes of yellow flowers with the petals distinct to the base.

Three subspecies may be distinguished. These differ primarily in vegetative characteristics. All have been transplanted from the wild to Ithaca, New York, where they have been grown under uniform conditions. Since they continue to maintain their distinctive characteristics after three years of culture, they seem to be really different genetically, and not physiological variants. This conclusion is further supported by the fact that the three subspecies have different cultural requirements if one wishes to maintain each in optimum condition. The vegetative differences between the subspecies of *S. spathulifolium* and *S. Purdyi* are shown in plate 22, fig. 3.

KEY TO THE SUBSPECIES OF SEDUM SPATHULIFOLIUM

A. Leaves of rosettes 2–3 mm. thick, very pruinose; rosettes 1.0–6.0 cm. in diam.; stems of offsets 1.5–3 mm. thick, frequently leafy throughout, but with a rosette-like cluster of leaves at the apex	1b. *S. spathulifolium* subsp. *pruinosum*
AA. Leaves of rosettes green or glaucous, not decidedly pruinose, 1–2 mm. thick; rosettes 1–5 cm. in diam.; stems of offsets 1–2 mm. thick with the leaves usually restricted to the rosettes which are terminal on the shoots . .	B
B. Leaves glaucous, crenulate; stems of offsets 1.5–2 mm. in diam.; flowers 8–17 mm. in diam.	1a. *S. spathulifolium* subsp. *typicum*
BB. Leaves green, usually neither glaucous nor pruinose, minutely crenulate; stems of offsets 1–1.5 mm. in diam.; flowers 7–11 mm. in diam.	1c. *S. spathulifolium* subsp. *anomalum*

1a. SEDUM SPATHULIFOLIUM Hooker subsp. **typicum.** *Sedum spathulifolium* Hooker, Flor. Bor. Am. 1: 227. 1834. *S. californicum* Britton, Bull. N. Y. Bot. Gard. 3: 44. 1903. *S. Woodii* Britton, No. Am. Flora 22: 73. 1905.

The distinctive features of subsp. *typicum* are the glaucous leaves, the more slender habit compared with subsp. *pruinosum,* and the slightly larger size compared with subsp. *anomalum.* These vegetative differences are well demonstrated by figure 3 (pl. 22). In floral characters, the subsp. *typicum* is likewise intermediate between the other two subspecies. The three-parted cymes usually contain from 20–40 flowers which are 8–17 mm. in diameter.

EXPLANATION OF THE FIGURES. PLATE 22.

PLATE 22. HABIT STUDIES OF SPECIES OF SEDUM IN THE SUBGENUS GORMANIA. FIG. 1. *Sedum spathulifolium* subsp. *typicum,* cultivated in greenhouse at Ithaca; collected along Grave Creek, Josephine County, Oregon. Photo by W. R. Fisher. FIG. 2. *Sedum spathulifolium* subsp. *pruinosum,* on rocks along Pacific Ocean, south of Crescent City, California. Photo by Harold Trapido. FIG. 3. Rosettes cultivated in greenhouse at Ithaca: *a, Sedum Purdyi,* from canyon of Canyon Creek, Siskiyou County, California; *b, Sedum spathulifolium* subsp. *pruinosum,* from rocks along Pacific Ocean south of Crescent City, California; *c, Sedum spathulifolium* subsp. *anomalum,* from Yosemite National Park, California; *d, Sedum spathulifolium* subsp. *typicum,* from Josephine County, Oregon. Photo by W. R. Fisher. FIG. 4. Type collection of *Sedum spathulifolium* subsp. *pruinosum* var. "Cape Blanco," cultivated at Ithaca. Photo by W. R. Fisher.

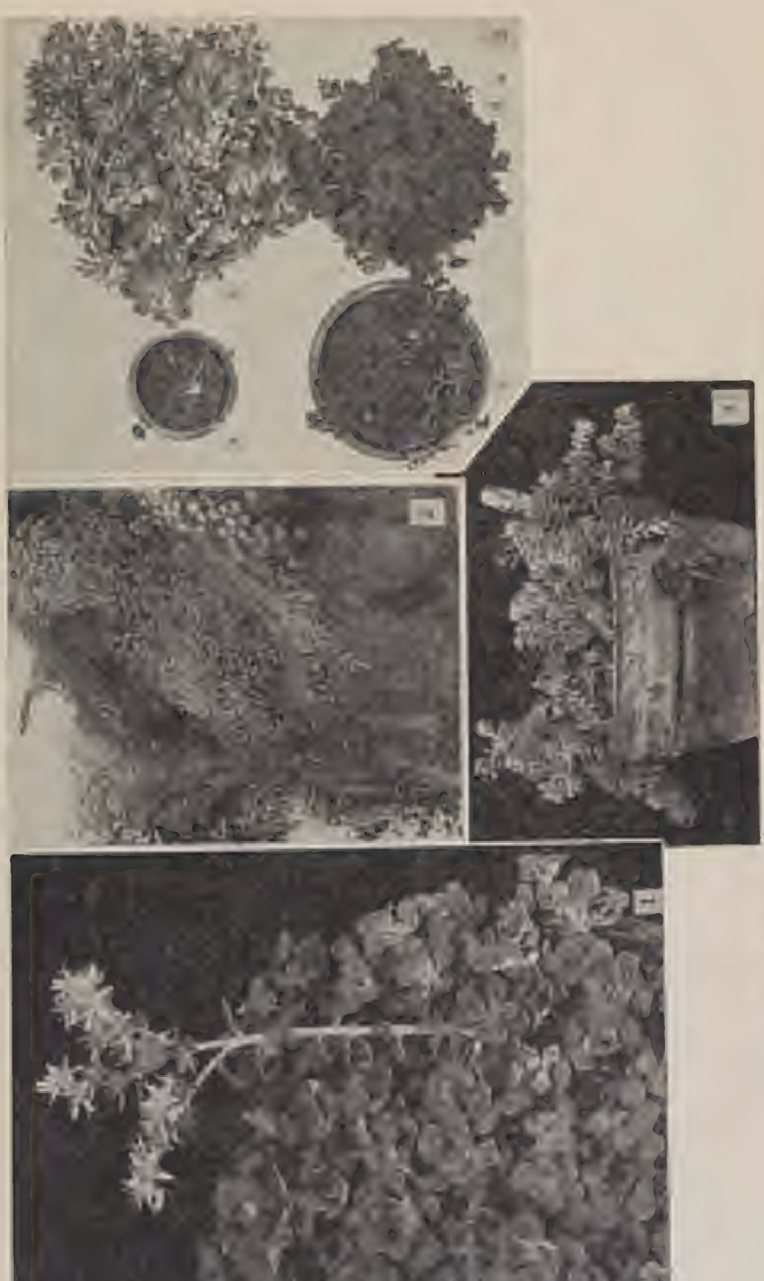

PLATE 4. HABIT STUDIES OF SPECIES OF SEDUM IN THE SUBGENUS GORMANIA

The subsp. *typicum* is widely distributed in the northern Coast Ranges, the Cascade Mountains and the northern part of the Sierra Nevada. It occurs from the lower Bella Coola and Fraser River valleys in British Columbia, to the Santa Cruz Peninsula in California. The altitudinal range is from 92 to 1920 meters. Since most of the specimens examined are without information about altitude, it is likely that this range will be increased as more data become available. The subsp. *typicum* usually grows in rocky places in ravines and canyons and on steep slopes.

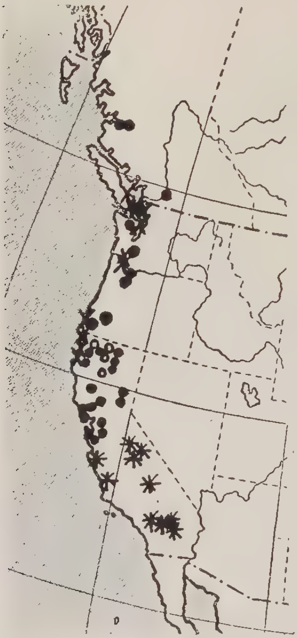

FIG. 2. Map showing distribution of the species and subspecies of the section *Rosulata* of *Sedum*: ● = *S. spathulifolium* subsp. *typicum*; × = *S. s.* subsp. *pruinosum*; * = *S. s.* subsp. *anomalum*; ○ = *S. Purdyi*.

Specimens seen. Highest altitude: 1920 m., 3 km. east of White Mt., Siskiyou Mts., Siskiyou Co., Calif., *Wheeler 3171* (NY); lowest altitude: 92 m., 3 km. south of Oregon City, Clackamas Co., Ore., *Clausen* and *Trapido 4925* (CU); northernmost: 52°30′ N., Burnt Ridge Creek, 50 km. east of Bella Coola, Skeena Co., B. C., *McCabe 1510* (UC) (Since the dried specimens are poor, their identity is questionable. This occurrence should be checked by further collections); easternmost: 120° W., Emigrant Gap, Calif., *Jones 3345* (CLOK, NY); westernmost: 124° W., Snow Camp Lookout, Curry Co., Ore., *Leach 2292* (ORE); southernmost: 37°30′ N., Los Gatos Cañon near Los Gatos, Santa Clara Co., Calif., *Heller 7422* (FM, UC); oldest: Sept. 25, 1861, summit of Mt. Diablo, Calif., *Brewer 842* (UC); type: not seen (collected by Douglas on dry rocks of the Columbia and Salmon rivers); types of names assigned to synonymy: north side of Mount Shasta, Siskiyou Co., California, alt. 5000–9000 ft., June 11–16, 1897, *Brown 336* (type of *S. californicum* Britton, NY); Oregon City, Oregon, 1866, *Wood* (type of *S. Woodii* Britton, NY). Number of collections seen: 63. Specimens of this subspecies examined in connection with the present study have been annotated as *Sedum spathulifolium* Hooker, subspecies A.

Hooker described *Sedum spathulifolium* as common on dry rocks of the Columbia and Salmon rivers. His description is not sufficiently complete to make positively certain which of the subspecies he was describing. Our basis for interpretation of the name rests on the plants which are the prevalent kind in the valley of the Columbia River. We have seen no specimens from as far inland as the Salmon River. The type specimen of *S. californicum* looks like typical *S. spathulifolium,* but the leaves are pruinose in the dried condition and Britton described the petals as white. Possibly the color of the flowers may have faded, as sometimes happens. Cooke, in a letter of January 13, 1941, and in a publication (6), questioned whether the specimens of *S. californicum* and other of Brown's collections really originated on Mt. Shasta. He favored the idea that they came from the eastern ridges or ranges of the Klamath Province. According to Cooke, A. A. Heller who knew Brown personally, wrote that no doubt all of Brown's *Sedum* collections were made somewhere on Mt. Eddy. As far as we understand the present distribution of these plants, this theory impresses us as reasonable, particularly since Cooke has been unable to find the plant on the north side of Mt. Shasta, and Trapido and the senior writer were likewise unsuccessful in their search there in 1940. At Oregon City, the type locality of *S. Woodii,* Trapido and the senior writer found *S. spathulifolium* frequent on rocks, but plants from there do not seem distinctive.

The time of flowering and fruiting depends somewhat on the latitude and on the altitude. Extreme dates of flowering for three districts, as determined from data with herbarium specimens, are:

Santa Cruz Peninsula, Calif. . . .	April 28–May 28
Western Oregon	May 9–June 24
Fraser River Valley, B. C.	June 15–July 15

A dwarf variety, collected originally at 1524 meters, at Snow Camp Lookout in Curry Co., Ore., has been designated by Henderson (in M. E. Peck, Man. High. Plants Oregon. p. 360. 1941) as var. *minus.* This may interest horticulturists and should be listed as a variety under subsp. *typicum.* The type is in the herbarium of the University of Oregon. Praeger's var. *purpureum* should be referred to subsp. *pruinosum* and his var. *majus* to subsp. *anomalum,* though both these varieties have in the past been placed under typical *S. spathulifolium.*

Plants of six collections have been studied cytologically. All are $n = 15$. Previously, Hollingshead (9) had reported a diploid number of 30 for three of the collections of *S. spathulifolium.* Collections for which the euploid number is now reported are: *Clausen* and *Trapido 4925,* South Fork of Eel River, 8 km. west of Hullville, Lake Co., Calif.; *Clausen* and *Trapido 5010,* north side of Grave Creek, 1.4 km. east of junction with Rogue River, Josephine Co., Ore.; *Clausen* and *Trapido 5022,* bluffs along east side of Willamette River, 3 km. south of Oregon City, Clackamas Co., Ore.; and *Clausen 77, 141* and *324,* all from cultivated sources. The chromosome complements of these several collections are sufficiently similar that one collection cannot be separated from another on a basis of the chromosomes. There is some variation in the size of the chromosomes in a complement, but none of the chromosomes are sufficiently distinctive to be identified.

Sedum spathulifolium subsp. *typicum* is frequent in the horticultural trade. It is grown in rock gardens and is usually correctly named as to species. Rarely it is listed as *S. Woodii.* The var. *minus* also is offered. Other varieties are listed, but these are either referable to other subspecies or are *nomina nuda.*

The first illustration of typical *S. spathulifolium* seems to have been published in 1883 in the Garden (vol. 24, page 462). An earlier plate which appeared in Gartenflora in 1872 is so poor that there is doubt whether the plant figured really is *S. spathulifolium.*

1b. SEDUM SPATHULIFOLIUM Hooker subsp. **pruinosum** (Britton) Clausen et Uhl, comb. nov. *Sedum pruinosum* Britton, No. Am. Flora 22: 72. 1905.

The distinctive characteristics of subsp. *pruinosum* are the very pruinose condition of the leaves, stems, floral bracts and calyx; the large size, with the leaves of the rosettes 2–3 mm. thick; and the stout sterile stems, 1.5–3 mm. thick, which are frequently leafy throughout, whereas in the other two subspecies the leaves usually occur only in dense rosettes at the ends of the shoots. In cultivation at Ithaca, subsp. *pruinosum* maintains its distinctive characteristics and thrives more successfully than do either of the other two subspecies. Also it seems to prefer more moisture. Whereas subsp. *anomalum* scarcely persists under the same conditions of culture, subsp. *pruinosum* becomes robust, flowers and spreads.

The subsp. *pruinosum* is restricted almost entirely to rocks and bluffs along the Pacific Ocean from near Little River, Humboldt County, California, to Nanaimo on Vancouver Island. In the "Preliminary Catalogue of the Flora of Vancouver and Queen Charlotte Islands" (10), the report of *Sedum spathulifolium* from the Queen Charlotte Islands may refer to subsp. *pruinosum,* but we have not seen specimens from there. The altitudinal range is not great, essentially from sea-level to about 30 meters or perhaps a little higher. The plants trail, creep or even hang over the boulders along the coast, often forming great patches or mats on the rocks. They must frequently be bathed in the spray of the surf. Two collections from along the lower course of the Columbia River and several from the islands of Puget Sound suggest that this population is connected with the population of subsp. *typicum* of inland districts by specimens somewhat intermediate in character and should not be segregated as a separate species. This opinion must yet be checked by genetical experiments.

Specimens seen. Highest altitude: 30 m., coast bluffs near Trinidad, Humboldt Co., Calif., *Tracy 2582* (UC); lowest altitude: 3 m., 8 km. south of Crescent City, Del Norte Co., Calif., *Clausen* and *Trapido 4937* (BH, CU, NY, US); northernmost: 49°10′ N., Nanaimo, *Rosendahl 1886* (CLOK); easternmost:

122°30′ W., Lummi Island, Whatcom Co., Wash., *Muenscher 7930* (CU); westernmost: 124°10′ W., Gold Beach, Curry Co., Ore., *Hoyt 64* (DS); southernmost: 41°2′ N., south of Little River, Humboldt Co., Calif., *Wiggins 5878* (FM, UC); oldest: 1887, Cedar Hill, Vancouver Island, B. C., *Macoun* (NY); type: Crescent City, California, 1903, *Eastwood* (NY). Number of collections seen: 32. Specimens of this subspecies, examined in connection with the present study, have been annotated as *Sedum spathulifolium* Hooker, subspecies B.

Miss Eastwood sent Dr. Britton a fresh piece of her original collection. This was cultivated in New York and flowered there on May 8, 1904 (N. Y. Bot. Gard. no. 18748, *Rose 540*). The type appears pruinose and consists of two floral stems, plus a few leaves. There are really no good rosettes on the specimen. Living plants and herbarium specimens collected by Trapido and the senior writer on cliffs and ledges along the shore of the Pacific Ocean 8 km. south of Crescent City, on July 24, 1940 (*Clausen* and *Trapido 4937*) are good matches for the type of *S. pruinosum* and have been our basis for interpretation of the name.

Extreme dates of flowering are April 27 and July 24. The flowering period is more prolonged than in subsp. *typicum,* also it is earlier at any given latitude. Undoubtedly this feature may be explained, at least partly, on a basis of the lower altitude at which subsp. *pruinosum* occurs and the consequent milder climate.

Principal variations are in the color of the leaves and stems and in size. Praeger (12, p. 239) has described a var. *purpureum* with the leaves purple. We have grown this in Ithaca, having obtained specimens from two different horticultural sources. The plants are definitely referable to subsp. *pruinosum,* under which the variety should be listed. At least two other unpublished varietal names, likewise referable to subsp. *pruinosum,* are also in the trade.

Plants of two collections have been studied cytologically: *W. C. Muenscher 7930* from Lummi Island, Washington; and *Clausen* and *Trapido 4937* from Crescent City, California. Both collections are $n = 15$. Previously, Hollingshead (9) had reported $2n = 30$ in root-tips of the Muenscher collection (*7930*).

The subsp. *pruinosum* is probably as common in the horticultural trade as subsp. *typicum,* but it is usually offered as *S. spathulifolium.* Rarely it is listed as *S. pruinosum.* The var. *purpureum* is available under that or other varietal names indicating reddish foliage. This subspecies is definitely to be recommended for culture by eastern gardeners. Particularly desirable are plants of the type which probably originated at Cape Blanco in Oregon. We now name this as *Sedum spathulifolium* subsp. *pruinosum* var. **"Cape Blanco"** var. nov. Hort., with the rosettes 1–2 cm. in diam., usually densely crowded, and with the leaves small, convex dorsally and ascending. As type we designate the specimen (*S 266*), cultivated at Cornell University, Ithaca, which is shown in figure 4 (pl. 22).

Figure 2 (pl. 22) shows the habit of the plant in nature. A drawing of a flowering plant, probably to be identified as this subspecies, appeared in Gardeners Chronicle in 1876 (vol. 5, p. 821).

1c. SEDUM SPATHULIFOLIUM Hooker subsp. **anomalum** (Britton) Clausen et Uhl, comb. nov. *Gormania anomala* Britton, Bull. N. Y. Bot. Gard. 3: 30. 1903. *Sedum yosemitense* Britton, *ibid.*, p. 44. *S. anomalum* (Britton) Britton, No. Am. Flora 22: 72. 1905.

The most distinctive characteristic of *Sedum spathulifolium* subsp. *anomalum,* when seen in the field, is the non-glaucous condition of the leaves. This feature is likewise exhibited by cultivated specimens, whereas plants of the other two subspecies, when grown side by side with subsp. *anomalum,* under the same circumstances, exhibit the glaucous or pruinose condition. Another feature of subsp. *anomalum* is the usually smaller size, with the rosettes rarely more than 2.5 cm. in diameter. For the most part, the stems of the offsets are rather slender, 1–1.5 mm. in diameter.

The subsp. *anomalum,* found only in California, ranges along the west slope of the Sierra Nevada, from the region of Yosemite National Park southward to the San Bernardino and San Gabriel mountains. Along the coast it extends as far north as the headwaters of the Carmel River. It has been collected most frequently in the Sierra Nevada and the San Bernardino and San Gabriel mountains. The altitudinal range is from a little above sea-level to 2286 meters. The usual habitats are rocky slopes and hillsides, ravines and ledges.

Specimens seen. CALIFORNIA. Highest altitude: 2286 meters, San Bernardino Mts., *Crawford 911* (POM); lowest altitude: 30 m. ± ?, Gragg's Canyon, San Luis Obispo Co., *Moran 421* (BH); northernmost: 37°50′ N., Hetch Hetchy Valley, Yosemite National Park, *Hall* and *Babcock 3380* (UC); easternmost: 117° W., Bear Creek, San Bernardino Mts., *Pierce* (UC); westernmost: 121°30′, Pine Valley, head of Carmel River, *Goldman 762* (FM); southernmost: 34°2′ N., pipe line trail on Yucaipa Mts., *Reed 2769* (UC); oldest: 1865, Yosemite Valley and Mts., *Torrey* (NY); type: sandy hills in the path of strong daily sea winds, San Luis Obispo Co., June, 1883, *Summers* (NY); type of *Sedum yosemitense* Britton (NY), assigned to synonymy: Yosemite Valley between Vernal and Nevada Falls, 1677 m., July, 1902, *Hall* and *Babcock 3425.* Number of collections seen: 33. Specimens of this subspecies, examined in connection with the present study, have been annotated as *Sedum spathulifolium* Hooker, subspecies C.

A collection from the San Bernardino Mountains (*Clausen* and *Trapido 4748*), is a reasonable match for the type of Britton's

Gormania anomala and has been used by us as a standard in our comparison of living plants. A specimen from the type locality of *S. yosemitense,* in Yosemite Valley below Nevada Falls (*Clausen* and *Trapido 4802*), is a good match for the type of that species. Plants of the collections cited above (*4802* and *4748*), when grown under uniform conditions at Ithaca, became very similar and had the same cultural requirements. There seemed to be no real differences between these plants.

May and June are the principal months of flowering. Extreme dates when flowering specimens have been collected are April 30 and July 4, with one record of it being found in flower in the San Bernardino Mountains in November.

Two varieties of subsp. *anomalum* occur, one with white flowers and the other with the whole plant larger in size. The latter has been named var. *majus* by Praeger (12, p. 238). Our basis for referring it to subsp. *anomalum* rests on the fact that the leaves are green, not glaucous. Large specimens, similar to what Praeger has described, have been seen in the Santa Barbara Botanic Garden. These came originally from San Luis Obispo County and were collected by Reid V. Moran. This is the region of the type locality, but other plants from there were not nearly so large. It is possible that variety *majus* is only a physiological form, a response to richer soils, shade and increased moisture. If further collections from San Luis Obispo County should reveal that most of the plants from there are large and perhaps slightly glaucous, then *Gormania anomala* may need to be referred to subsp. *typicum* and the name *yosemitense* used for the subspecies of the Sierra Nevada and the San Bernardino and San Gabriel mountains.

Two collections, studied cytologically, are $n = 15$. These are from Cascade Canyon, San Gabriel Mountains, California (*Clausen* and *Trapido 4748*), and from below Nevada Falls, Yosemite Valley, California (*Clausen* and *Trapido 4802*).

Subspecies *anomalum* is rare in the horticultural trade. Judging from experience in growing it at Ithaca, it is difficult to maintain and less desirable than either of the other two subspecies.

Praeger's (12) illustration of *S. yosemitense* shows fairly well the aspect of subsp. *anomalum.*

2. SEDUM PURDYI Jepson, Fl. Calif. 2: 110. 1936.

Perennial with the stems procumbent or creeping, bearing flat rosettes of spatulate leaves; stems 1–4 mm. in diameter, 4–7 cm. long, light green to brown; leaves of rosettes closely imbricated with their apices pressed close together, spatulate or orbicular-spatulate, rounded or truncate at apex, papillose on margins, 0.1–1.8 cm. long, 1–10 mm. wide, 1 mm. thick, yellow-green, granulose ventrally, waxy dorsally, sometimes lustrous; primary stems with offsets below rosettes, these radiating like the spokes of a wheel and naked except for the rosettes at their apices, 1.5–7 cm. long, green; floral stems erect or slightly decumbent, 0–16 cm. high, 2–3 mm. thick below the inflorescence, with the leaves alternate, oblong-spatulate, spreading, 0.3–1.5 cm. long, 1–4 mm. wide; inflorescence a three-parted cyme of 10 to 39 flowers, with a central flower; floral bracts oblong-spatulate to linear, 2.5–5 mm. long; flowers sessile or short-stalked on pedicels to 2 mm. long, usually 5-merous, 1.5 cm. in diameter; sepals linear-lanceolate, obtuse or subacute, green, 2–2.5 mm. long; petals lanceolate, acute, 5–7 mm. long, spreading above the base, bright yellow to white; stamens 4 mm. long, anthers yellow or white; nectar scales 0.8 mm. long, 0.5 mm. wide, transversely oblong; pistils erect or divergent, gibbous ventrally, 4–7 mm. long, with the styles 1–2 mm. long; seeds pyriform, yellowish-brown, 0.8 mm. long.

The present known range of *Sedum Purdyi* is in the southern portion of the Klamath Mountains in northern California. We have seen specimens from altitudes of 183 to 617 meters, but Jepson mentioned the upper limit of altitudinal range as 4000 feet (1219 meters). The usual habitats are ledges and rocky slopes in shaded situations.

Specimens seen. CALIFORNIA. Highest altitude: 617 meters, east side of corral of Canyon Creek Camp, 1.6 km. up Canyon Creek from Scott River, 19 km. south of Hamburg, Siskiyou Co., *Clausen* and *Trapido 4983* (CU); lowest altitude: 183 meters, Somes Bar, Siskiyou Co., *Tracy 16271* (UC); northernmost: 41°36′ N., same as highest altitude; easternmost: 122°40′ W., near French Gulch, Shasta Co., *Rose* (CAS) (Jepson has cited the easternmost locality as Kennett, but we have seen no specimens from there); westernmost: 123°30′ W., same as lowest altitude; southernmost: 40°42′ N., same as easternmost; oldest: Aug. 21, 1908, Etna Creek, Siskiyou Co., *Butler 498* (CAS, UC); type: not seen (Etna Mills, Calif., Carl Purdy). Number of collections seen: 7.

A collection from ridges along Canyon Creek, Siskiyou County, California (*Clausen* and *Trapido 4983*) agrees for the most part with characters given in the original description of *S. Purdyi* and matches specimens from Mr. Purdy's nursery. This collection has been our basis for interpretation of the species. The rosettes are flat with the leaves closely compressed; the margins of the leaves are prominently papillose; and the petals are yellow, not white as stated in the original description. For directions to the locality at Canyon Creek, the senior writer wishes to express his gratitude to Mr. J. T. Howell of the California Academy of Sciences.

The flowering time is late in April. Flowering dates obtained from herbarium specimens are April 23 and April 29. Fruiting specimens with ripe seeds have been collected in late July. Plants obtained in flower in the Marble Mountains in August were probably blooming abnormally, since the usual time seems to be in the spring.

No noteworthy variations of *Sedum Purdyi* have come to our attention. The species seems nearest to the subsp. *anomalum* of *S. spathulifolium* and, like that, is difficult to grow in the eastern part of the continent. Some specimens of the subsp. *anomalum* have appeared so similar to *S. Purdyi* that we have had difficulty in separating them, but usually the rosettes of *S. Purdyi* are more compressed and the margins of the leaves are more prominently papillose.

Plants of the collection from Canyon Creek Camp, cited above (*Clausen* and *Trapido 4983*), have been studied cytologically. These are $n = 15$.

Sedum Purdyi is occasionally offered in the horticultural trade and is usually correctly named.

Figure 3 (pl. 22) shows rosettes of the three subspecies of *S. spathulifolium* and of *S. Purdyi*. Note the slender stems of the secondary rosettes of the latter species.

Section Eugormania Clausen

Gormania Britton, Bull. N. Y. Bot. Gard. 3: 29. 1903. Named in honor of M. W. Gorman of Portland, Oregon. Type species: *Cotyledon oregonensis* Watson (*Sedum oregonense*).

A detailed discussion of this section has already appeared in print (3). For convenience, the key to species and the keys to the subspecies of *S. obtusatum* and *S. laxum*, with slight emendation, are repeated here. Otherwise, data are presented only when they are supplementary to the information in the earlier paper.

Key to the Species of Eugormania

A. Inflorescence and upper part of stem glandular pubescent, strongly reflexed before flowering time; leaves of rosettes glandular-ciliate; petals yellow .... 6. *Sedum Moranii*
AA. Inflorescence and upper part of stem glabrous, usually erect before flowering time; leaves of rosettes usually not ciliate; petals yellow, white or pink .... B
  B. Flowers yellow or pale yellow, sometimes fading to white or pink in age; inflorescence a paniculate cyme; leaves of rosettes 1–3.5 cm. long .... 3. *Sedum obtusatum*
  BB. Flowers white, creamy white or pink; inflorescence a dense paniculate or corymbose cyme; leaves of rosettes 1–4.5 cm. long ... C
    C. Flowers white or creamy white; sepals ovate, 2–3 mm. long .... 4. *Sedum oregonense*
    CC. Flowers pink or pale pink, rarely white; sepals lanceolate or ovate, 2–5 mm. long .... 5. *Sedum laxum*

3. Sedum obtusatum A. Gray

Mr. Jack Whitehead has sent some large specimens collected originally by Mr. George B. Youngs from along the North Fork of the Feather River, 4 km. north of Belden, Plumas County, California, and at an altitude of about 915 meters. These are characterized by very large rosette-leaves, up to 5 cm. long. The petals are pale yellow. These plants seem referable to *S. obtusatum,* but match neither subsp. *typicum* nor subsp. *boreale.* It is possible that they may represent an undescribed subspecies, since no material has previously been available from the Feather River region. One might expect that *Sedum obtusatum* from that section would be intermediate between the two described subspecies, but samples of the plants obtained by Mr. Youngs are larger than either of the other two races.

KEY TO THE SUBSPECIES OF SEDUM OBTUSATUM

A. Basal leaves relatively small, 0.5–2.5 cm. long, usually broadly rounded or truncate at apex; stems of rosettes bright red .... 3a. *S. obtusatum* subsp. *typicum*

AA. Basal leaves usually larger, 1–3.5 cm. long, usually retuse at apex; stems of rosettes pale red or pink .... 3b. *S. obtusatum* subsp. *boreale*

3a. SEDUM OBTUSATUM A. Gray subsp. TYPICUM.

No new data have accumulated regarding this subspecies.

3b. SEDUM OBTUSATUM A. Gray subsp. BOREALE Clausen.

A plant of the type collection (*Clausen, Trapido* and *Cooke 4952*) flowered in a greenhouse at Ithaca on May 7, 1943. The stamens were red and the carpels were suffused with red. The petals spread rather widely above the middle. The length of the basal leaves ranges up to 3.5 cm. long.

The senior writer wishes to express hearty thanks to W. B. Cooke for guiding him and Mr. Trapido to the locality on Mt. Shasta where subsp. *boreale* occurs.

4. SEDUM OREGONENSE (Watson) M. E. Peck.

The inflorescence is a paniculate cyme, not a true panicle. A plant, originally from Crater Lake, which flowered indoors at Ithaca, had yellow anthers.

5. SEDUM LAXUM (Britton) Berger.

Further study of living plants in cultivation necessitates a few changes in the key to the subspecies.

KEY TO THE SUBSPECIES OF SEDUM LAXUM

A. Plants tall and robust, 25–45 cm. high; leaves dark green to glaucous; stems of sterile rosettes pink, 4–6 cm. long; petals pale to deep pink .... 5b. *S. laxum* subsp. *typicum*

AA. Plants not as tall as above, 10–25 cm. high; leaves yellow-green or blue-green, usually glaucous; petals pink, pale pink to white suffused with pink	B
B. Inflorescence congested; rosettes closely crowded, forming a dense mat, with the leaves rather thin; stems of sterile rosettes green to black, 1.5–2 cm. long	5d. *S. laxum* subsp. *retusum*
BB. Inflorescence lax; rosettes not closely crowded, forming a loose mat, with the leaves thick and leathery	C
C. Rosette-leaves very broad, 2.0–3.0 cm. wide, triangular, obcordate, sometimes not glaucous; petals pale pink to white	5c. *S. laxum* subsp. *latifolium*
CC. Rosette-leaves narrow, 0.3–2.0 cm. wide, oblong-oblanceolate or spatulate, usually glaucous; petals pink	D
D. Cauline leaves oblong-spatulate, longer than broad	5a. *S. laxum* subsp. *perplexum*
DD. Cauline leaves cordate to subcordate, about as broad as long	5e. *S. laxum* subsp. *Heckneri*

5a. Sedum laxum (Britton) Berger subsp. perplexum Clausen. No new data have come to hand.

5b. Sedum laxum (Britton) Berger subsp. typicum. Cultivated specimens originally from the type locality exhibit some variation in the glaucous condition of the leaves. Some rosettes are less glaucous than others. A collection of Clausen (*5018*) is $n = 15$. Previously, Dr. Hollingshead had reported a diploid number of 30 for this same collection. A cultivated plant, received as *Sedum Jepsoni,* is *Sedum laxum* subsp. *typicum.* That binomial was introduced into the literature by H. M. Butterfield (Desert Plant Life 8: 7. 1936).

5c. Sedum laxum (Britton) Berger subsp. latifolium Clausen. A specimen of the type collection, cultivated in a greenhouse at Ithaca, flowered in the spring of 1943. The inflorescence was 15 cm. long and 6 cm. wide. The stamens were 6–7 cm. long with the anthers red and the filaments white to pink. The pistils were 8 mm. long with the ovaries green and the styles and stigmas pink.

5d. Sedum laxum (Britton) Berger subsp. retusum (Rose) Clausen. Two additional years of culture of this subspecies have not affected its characteristic manner of growth. Cytological study of University of California no. 28.3 from Mendocino County, California, indicates that the haploid number is 15.

5e. Sedum laxum (Britton) Berger subsp. Heckneri (Peck) Clausen. No new data have become available regarding this subspecies.

6. Sedum Moranii Clausen. No new localities for this rare species have come to our attention.

Summary

The subgenus *Gormania* of *Sedum* includes six species which together constitute a natural phylogenetic group restricted to the Pacific Mountain System of Western North America. Taxonomic, geographical and cytological data all confirm this opinion. The chromosome number, with one exception, is $n = 15$, $2n = 30$. The exception is *S. oregonense,* of which the only plants so far studied are hexaploid. The species may be grouped in two sections, *Rosulata* and *Eugormania,* the former the more primitive. The section *Oreganica,* based on *Sedum oreganum,* does not belong in *Gormania* and should be referred elsewhere. The section *Rosulata* includes two species, *S. spathulifolium* and *S. Purdyi.* The section *Eugormania* includes the other four species: *S. obtusatum, S. oregonense, S. laxum* and *S. Moranii.* New botanical names are *S. spathulifolium* subsp. *pruinosum* and *S. s.* subsp. *anomalum.* A possibly undescribed subspecies of *S. obtusatum* is mentioned from the Feather River region in Plumas County, California.

Department of Botany,
Cornell University, Ithaca, New York,
July, 1943.

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J. W. STACEY, CARICOLOGIST

John Thomas Howell

That Mr. J. W. Stacey should have studied western carices was inevitable. His interest in this difficult group had been aroused years before by Charles Fay Wheeler when he was scarcely more than a lad in the Middle West and under Wheeler he made his first studies. For all the years that he had lived in San Francisco, systematic botany had been his chief interest outside of his business and the Glumiflorae had been more attractive to him than any other group. Hence, in 1933, when Miss Eastwood asked her long-time friend to determine for her a formidable accumulation of carices which K. K. Mackenzie had just declined to examine because of ill health, Mr. Stacey gladly consented. A concurrent reorganization of his business allowed him more time to himself and it was not long before he was deeply engrossed in a study of *Carex* in Western North America with ambitious plans for a revision of the genus in the United States west of the Rocky Mountains. Thus this chain of events brought to Western Botany its only resident caricologist and centered his work at the California Academy of Sciences. For five years he pursued his systematic studies intensively but, due to a heart ailment which finally prevented the use of the microscope, he was unable to continue after 1939. Not only did Mr. Stacey contribute a great deal to our knowledge of western *Carex* but in this often-neglected genus he awakened a widespread interest among field workers that for many years will attest the influence of his vital and infectious enthusiasm.

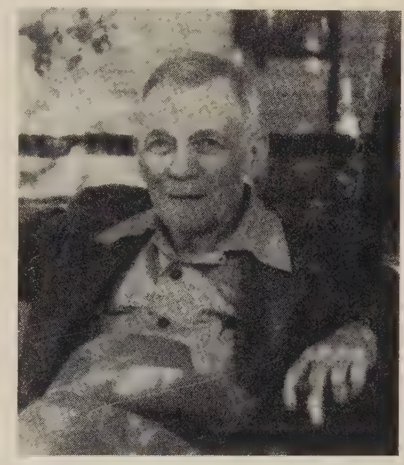
Fig. 1. J. W. Stacey, summer, 1942.

Mr. Stacey was fundamentally interested in species and favored all means for detecting them, whether by morphology, cytology, or physiology. Although he himself relied chiefly on morphology in his taxonomic work, he welcomed data from the other fields of botany as a possible source of information for distinguishing closely related entities. With well-balanced judgment and keen discernment he made his analytical studies and he derived much pleasure from searching out the identity of some miserable but challenging fragment. He believed that species, when once properly circumscribed, exhibited at least one character (not necessarily a "key-character") by which they could be recognized at some period in their life history. When once he had this exclusive character clearly in mind, he knew his species and could recognize it no matter how variable it might be. Henceforth for him the species was "fixed" and rarely could he be persuaded to accept for it any subdivision into varieties.

Although his work with *Carex* was seriously conceived and executed, nevertheless the time he spent in study was really his period of recreation and relaxation away from business. It pleased him to make a sociable time of it, discussing the plant he had before him, expounding some theory of relationship or distribution, criticizing or praising some treatment in the work of Mackenzie for whom he had great admiration. In the herbarium or on field trips he talked of little else but *Carex,* a source of annoyance to non-botanical acquaintances who sometimes accused him of being narrow-minded. One of his chief sources of delight in conversation was to catch up unwary persons by exposing some scientific fallacy or rhetorical exaggeration in their speech. If a verbal tilt developed, he was never acrimonious nor argumentative, always allowing his adversary the satisfaction of justifying his statement; but from the twinkle in Mr. Stacey's eye one knew who had won, who had had fun. To fellow botanists he was generous of his means and knowledge but only so long as he felt he was being accorded an honest and true return in science and friendship.

As an amateur botanist interested in the general systematic botany of western vascular plants Mr. Stacey was one of the keenest and best-informed. Very few are the professional botanists who could have surpassed him in a knowledge of plants as they grow, a knowledge gained from methodical study while on recreational strolls and trips over a period of many years. In an attempt to organize the taxonomic data obtained on these outings, he prepared lists of plants for each of the counties bordering San Francisco Bay which are more complete than anything of which I know and which contain many entries indicative of his keen power of observation and his scholarly discernment.

The fullest scientific use of these lists cannot be realized unfortunately because only the exceptional entry is represented by a herbarium specimen for reference. Although a brilliant all-around field naturalist, Mr. Stacey was in no sense of the word a botanical collector. For him it was enough to search out the rarest plants where they grew, leaving to amateur collectors or professional botanists the task of preserving scientific herbarium records. A few specimens of his collecting will be found in the herbarium of the California Academy of Sciences but they are frequently represented by mere scraps or fragments sent to Miss Eastwood for determination or verification. After he seriously undertook the study of western carices, he made a real effort to try to collect; but his almost-untouched stock of printed labels shows that his own activity as a collector fell far short of his intentions. How well I remember the collecting trips that he and I made to such rich localities as the *Ledum* swamp on the road to Point Reyes or to the Pitkin marsh in Sonoma County: while Mr. Stacey would freely wander about intent on plants in general and *Carex* in particular, I would spend most of my time digging and picking, collecting and pressing, specimens! The superb research collection of West American *Carex* in the herbarium of the California Academy of Sciences, however, proves that one need not be a collector to build a collection.

The published results of Mr. Stacey's research in *Carex* appeared chiefly as a series of "Notes on Carex" in Leaflets of Western Botany, volumes 1 and 2, from November, 1934, to February, 1939. There were fifteen contributions in this series which include descriptions of seven new species besides extended distributional data and notes on the identity of various critical species. His only other botanical writings of which I know are "Notes on some plant introductions, mostly Californian" (Leafl. West. Bot. 1: 69–71. 1933), and his treatment of the genus *Carex* in Kearney and Peebles Flowering Plants and Ferns of Arizona (U. S. Dept. Agric. Miscell. Publ. no. 423, pp. 168–175. 1942). A notice of Mr. Stacey's death appeared in Science (n. ser. 98: 464. 1943) and a brief obituary was published in Academy News Letter no. 48 (December, 1943).

When no longer able to give his serious attention to *Carex,* Mr. Stacey turned to another field of natural science and devoted his time and interest to ornithology. To this study he brought the same enthusiasm, the same critical discernment, which characterized his work in botany. Concerning his ornithological activity, the following was written in Academy News Letter no. 48: "In two or three years he had developed a field knowledge of birds that was surprising even to veteran observers. The new interest he had taken up at sixty-eight he pursued with the same intensity and thoroughness that had characterized all of his activities throughout his life; and after his death his executors found among his papers literally almost half a bushel of carefully written manuscript notes on birds."

John William Stacey was born in Galesburg, Michigan, on February 26, 1871, and died in San Francisco, California, October 16, 1943. His wife, the former Mrs. Florence Ward Waite whom he married in St. Louis shortly before coming to California, survives him. He attended the University of Michigan at Ann Arbor, taking courses in medicine and botany, and at least during one summer did botanical field work with C. F. Wheeler. After completing his medical course, he went to the Bellevue Hospital as an interne, but instead of completing his work and practicing, he specialized in the further study of drugs and took up editorial work for medical publications. He came to San Francisco in 1914 where, shortly after, he became connected with the book department of The Emporium, first as head of the medical book department and later as head of the entire book department. In 1923 he founded the business firm of J. W. Stacey, Inc., which soon attained importance as an institution in medical and scientific circles throughout Western America. Evidence of the high esteem in which Mr. Stacey's store is held is observed in the fact that medical students are urged by their instructors to browse through his stock of books to acquaint themselves with the most recent literature of their field.

Although Mr. Stacey was always a scientist at heart, with particular interests in systematic botany and ornithology, these fields of scientific endeavor did not attract him professionally. His success in the business world was due in no small degree to his deep attachment to science, for it was the rare combination of his thoroughly scientific background, his naturally keen business ability, and his happy and animated personality that accounted for a career that was eminently successful and in some respects unique.

California Academy of Sciences,
San Francisco,
January, 1944.

DERMATITIS AND PHOTOSENSITIZATION PRODUCED BY PTELEA ANGUSTIFOLIA

W. C. Muenscher and Babette I. Brown

In the summer of 1942 and again in 1943 workmen in Highland Park, Rochester, New York, received a severe dermatitis believed to have been caused by contact with the leaves of *Ptelea angustifolia* Benth. (*P. lutescens* Greene), a member of the Rutaceae. Other plants in this family, *Dictamnus albus* L. and *Ruta graveolens* L. are known to cause a dermatitis in susceptible individuals but no records could be found of dermatitis caused by any species of *Ptelea*. This note is a report of some tests made by us which demonstrate that *Ptelea angustifolia*, a native shrub of the Southwestern United States, also may cause a severe dermatitis in some individuals.

The fresh material used in these tests was kindly supplied by Mr. R. H. Horsey, from introduced shrubs growing in Highland Park. We are indebted to Dr. Joseph N. Frost of Ithaca for his interest in the tests, for advice, and for the treatment of some of the more severe cases of dermatitis in two of the subjects.

Eight persons, all volunteers, were used as subjects in the tests: subjects 1 and 3, adult white females; subjects 2, 4, 7 and 8, adult white males; subjects 5 and 6, adult oriental males.

EXPERIMENTS WITH PTELEA ANGUSTIFOLIA

The tests are recorded under time of exposure, subjects used, method of application and reactions or results obtained with each subject.

EXPOSURE 1. August 4, 9 A.M. Subjects 1 and 2.

Crushed leaves were rubbed, on an area 2 cm. in diameter, above the elbow of the left arm. Direct sunlight was excluded.

Subject 1. A slight reddening of the skin appeared over an area 3 by 4 cm. in diameter four lays later. The color remained the same for four days and then began to fade. The spot was still visible on the tenth day when a slight itching was perceived.

Subject 2. No reaction.

EXPOSURE 2. August 4, 9 A.M. Subjects 1 and 2.

Crushed immature fruits were rubbed over an area 2 cm. in diameter below the left elbow. Direct sunlight was excluded.

No reaction occurred in either subject.

EXPOSURE 3. August 7, 1 P.M. Subjects 1, 2 and 3.

Crushed leaves were vigorously rubbed, on an area 3 cm. in diameter, far above the elbow on the left arm of subjects 1, 2 and 3, and also on the right upper arm of subject 1 and on the center of the upper back of subject 2. The areas were subsequently exposed to direct sunlight for one hour. A severe dermatitis developed in subjects 1 and 2 and a moderate dermatitis developed in subject 3. The development and history of the dermatitis on subjects 1 and 2 are recorded below; the hours or days indicate total time elapsed since the original exposure to contact with the leaves.

Subject 1. Right arm.

18 hrs. A small faintly red area was discernible.

30 hrs. A red area, 5 by 7 cm., was definitely outlined; it burned much as a sunburned skin.

40 hrs. The inflamed area, now 7 by 7 cm., was very sensitive and pained when touched.

48 hrs. Frank vesiculation appeared and edema began to develop.

52 hrs. Smaller blisters became confluent; one large blister had increased to 2 cm. in diameter.

54 hrs. Blisters were cut open, drained of yellow fluid and covered with dressing and kept moist with dilute boric acid for the following four days. After the fifth day the inflammation began to subside and considerable itching was experienced. The maxi-

mum size of the blistered area, 6 by 8 cm., was reached on the sixth day. The blistered area developed new skin within a few days but it remained reddish-brown for two months.

The exposure on the left arm developed into a similarly severe dermatitis on an area 5 by 13 cm. within thirty hours. Its general course ran almost identical with that described for the right arm. The same treatment was applied.

Subject 2. Left arm.

18 hrs. A reddish spot 6 by 6 cm. was discernible.

30 hrs. Inflamed area red, 7 by 10 cm., with small whitish vesicle near the center.

40 hrs. Inflamed area 7 by 12 cm., with vesiculation especially near the center.

52 hrs. Frank vesiculation but some blisters becoming confluent, some 2 cm. in diameter and at least 1 cm. high, edematous; several had ruptured and were discharging a yellow fluid.

54 hrs. Blisters were cut open, drained and covered with dressings and kept moist with dilute boric acid solution for the following four days. After the fifth day the inflammation began to subside but considerable itching was experienced from then on for ten days. Even six weeks after exposure itching was severe whenever the subject perspired or became over-heated. The affected area was still reddish-brown after two months. The exposure on the back ran a course very similar to that on the arm except that the area was larger, 8 by 10 cm., with two radial streaks 2 by 6 cm. long extending toward the neck.

Subject 3. Left arm.

A reddish spot 6 by 8 cm. appeared within eighteen hours. It became more inflamed and small blisters developed within three days. The general appearance of the dermatitis was similar to that in subject 1 but much less severe. The affected area remained dark reddish brown for two months and then began to fade gradually but it was still visible fifteen weeks after the beginning.

Exposure 4. August 9, 7 A.M. Subjects 1 and 2.

Crushed leaves were rubbed on an area 3 cm. in diameter on the inner side above the elbow of both arms (subject 1) and on the right arm (subject 2). Direct sunlight was excluded.

No reactions were observed in either subject.

Exposure 5. August 14, 2 P.M. Subjects 1, 2 and 3.

Crushed leaves were rubbed lightly, on areas 1 cm. square, on the inner side of the right arm both above and below the elbow.

Direct sunlight was excluded.

No reactions were observed in any subject.

Exposure 6. August 9, 2 P.M. Subjects 4, 5, 6, 7 and 8.

A small piece of crushed leaf was rubbed on an area approximately 2 cm. in diameter above and below the elbow of the left arm of each subject. The arm was not exposed to direct sunlight. Subject 4 developed a slight reddening of the skin of both areas of exposure four days later. Subjects 5, 6, 7 and 8 showed no reactions.

Experiment with Dictamnus albus

August 7. Subjects 1, 2 and 3.

Crushed leaves were rubbed on an area 2 cm. in diameter on the right upper arm. The treated areas were exposed to diffuse sunlight for one hour.

No reaction developed in subjects 1 and 3. A severe dermatitis developed in subject 2. Within eighteen hours a red inflamed area, 5 cm. in diameter, had developed. It increased to 6 by 7 cm. and blisters developed. The general course of the development of the dermatitis and its response to the boric-acid solution treatment were very similar to that of *Ptelea angustifolia.*

Experiment with Ruta graveolens

August 7. Subjects 1, 2 and 3.

Crushed leaves were rubbed on areas 2 cm. in diameter on the outside of the lower right arm of subjects 1 and 3, and on the extreme upper right arm of subject 2. The treated areas were exposed to direct sunlight for one hour.

A slight reaction was obtained in subjects 1 and 3. After thirty hours a definite reddening and inflammation of the skin was discernible over an area 5 by 7 cm. in subject 1 and on an area 7 by 12 cm. in subject 3. This was followed by more severe inflammation and itching but no vesiculation.

Subject 2 developed a severe dermatitis. Within eighteen hours after contact a red inflamed area 8 cm. in diameter was evident. After thirty hours the spot had increased to 10 by 11 cm. with frank vesiculation. The blisters soon became confluent and from then on the general appearance of the dermatitis and its response to treatment with boric-acid solution were identical to that caused by *Ptelea angustifolia.*

Of the eight subjects tested, three were highly susceptible to contact with the leaves of *Ptelea angustifolia,* one was slightly susceptible and four showed no reaction under the conditions of the tests. Subjects 1 and 2 developed only a slight reaction if not exposed to direct sunlight after contact with the leaves but developed a severe dermatitis if exposed to direct sunlight for one hour after contact. Of the five subjects who were tested without subjecting them to direct sunlight after contact, only one showed a slight reaction.

The three subjects who were highly susceptible to *Ptelea angustifolia* were also tested for susceptibility to *Dictamnus albus* (gas plant) and *Ruta graveolens* (rue). Subject 2 was highly susceptible to all three species. Subjects 1 and 3 showed no reaction to *Dictamnus albus* and a slight reaction to *Ruta graveolens.*

SUMMARY

Contact with the leaves of *Ptelea angustifolia* causes a dermatitis in susceptible individuals. Exposure to direct sunlight subsequent to contact increases the severity of the dermatitis. This suggests that *Ptelea angustifolia* has a photosensitizing action. The dermatitis caused by *Ptelea angustifolia* is very similar to that produced by *Dictamnus albus* and *Ruta graveolens.* In the experimentally produced dermatitis the first inflammation appeared eighteen to thirty hours after contact with the leaves. The severe cases continued for about ten days.

Department of Botany,
Cornell University,
December, 1943.

ON THE SHOOT APEX OF CHLOROGALUM POMERIDIANUM (DC.) KUNTH[1]

CLARENCE STERLING

Recent investigations on the structure of apical meristems have rekindled interest in the cyto-histology of the shoot apex as contrasted to the more static formulation of cell-wall patterns. (See reviews by Foster, 5; 6.) One of the main services of these studies has been to show the essential lability inherent in plant tissues and the consequent inadmissibility of posing strict categories and formulae within which plant life is to function.

Probably one of the most rigid "laws" imposed on the angiosperm shoot apex is that it have at least one stratum of cells which experiences anticlinal divisions exclusively, this cell layer being called variously a "dermatogen" or "tunica." Very few exceptions to this basic rule have been noted. Magnus (7) indicated divisions in the dermatogen of the tip of the lateral pistillate inflorescence of *Secale cereale;* Pottier figured such a pericline at the tip of a branchlet of *Ruppia maritima* (8, fig. 77) and in the apical meristem of the shoot of *Cymodocea nodosa* (8, fig. 197); and more recently Sharman (11, 12) found periclines at the summits of the

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[1] The writer wishes to acknowledge the helpful advice and criticism of Dr. A. S. Foster in the preparation of the manuscript.

shoot apices of *Zea mays* and *Agropyron repens,* respectively. The apices of *Phoenix,* as figured by Ball (2), also indicate irregularities in the uniseriate tunica, possibly involving sporadic periclines. Aside from phylogenetic implications for the monocots, these observations have a significance in challenging fixed concepts on the structure of the angiosperm shoot apex.

The present discovery resulted during experimentation on shoot apices with various fixatives. One of these experiments involved specimens of *Chlorogalum pomeridianum,* collected in April, 1941, near Fairfax in Marin County, California. Slides were made of the shoot apices of two bulbs. The sections were serial longitudinal, cut eight micra thick. Because of poor fixation of the apices, drawings were made by the camera lucida technique.

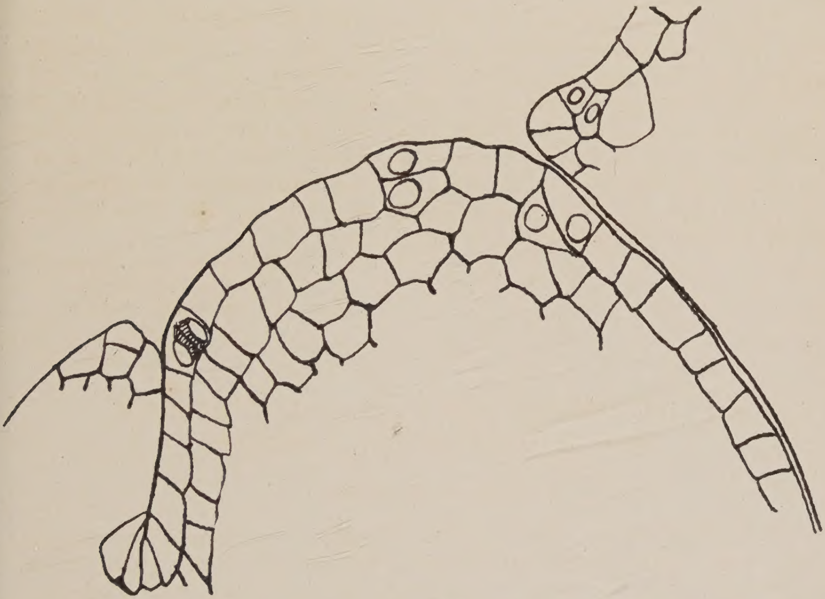

FIG. 1. Longitudinal section in near-median view of shoot apex of *Chlorogalum pomeridianum* (× 485).

One of the apices, perhaps cut somewhat obliquely, shows only slight indications of previous periclinal divisions in the surface layer of cells. In the second apex, there is very definitely no discrete surface layer. Periclinal divisions have occurred at various places in this layer, both at the summit and on the flanks, with high frequency. Text figure 1, which is definitely median or near-median, shows several distinctive features of this apex:

derivatives of two periclinal divisions are observable at the summit of the shoot apex. An anticlinal mitosis on the left flank indicates that cell division is active. Both leaf primordia show periclinal divisions at their tips.

In text figure 2, the periclines in the surface layer of the leaf primordia apices stand out particularly well. This section is only eight micra removed from that of text figure 1, being the adjacent cut. In this diagram, part of the wall of one of the periclinal divisions of the previous section and a different aspect of the second pericline are recognizable at the shoot apex. Periclines are visible on the left flank of the apical cone. The four cells here seem to be the derivatives of a single superficial cell, possibly as a result of a periclinal division immediately succeeded by anticlines in the daughter cells. The heavily-walled, deeply stained cell at the upper right of the figure is seemingly merely coincidental in occurrence in the apex.

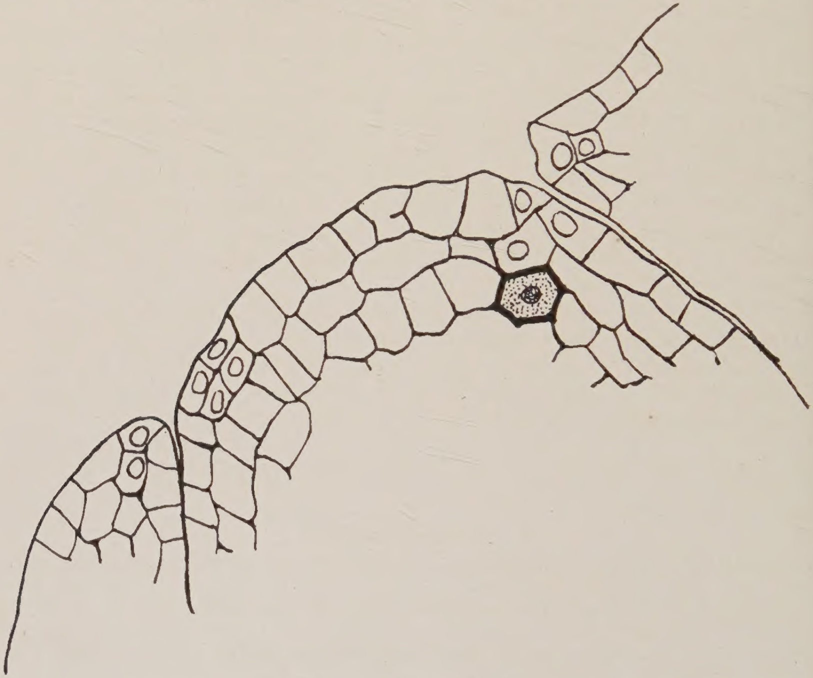

Fig. 2. Longitudinal section of shoot apex of *Chlorogalum pomeridianum*, 8 micra removed from section in fig. 1 (× 485).

Discussion

Agnes Arber (1) has noted, in her discussion of the morphological nature of leaf and shoot, the general equivalence of "tunica" and "corpus" in the initial regions of stem and leaf in angiosperms as well as the similarity, and even concurrence, in the manner of apical growth of these two organs in most of the general divisions of plants. This thesis is also a point of departure for Catalano's (4) support of Delpino's phytonic concept. These generalizations, however, are merely philosophical derivations from a group of basic anatomical data.

However, at present considerable data have been accumulated on the behavior of leaf and shoot apices in the monocots. The occurrence of periclinal divisions in the surface layer of the leaf apex of these plants is a well-established fact. As Sharman (11) points out, "In the Dicotyledons it may be involved in the production of the leaf edge, while in the Monocotyledons it is frequently concerned in the initiation of the leaves and often contributes considerably to their inner tissues." Sharman has cited most of the investigators who have observed periclines in the dermatogen of the monocot and dicot leaves. To his list can be added the works of Renner (9), Buder (3), Pottier (8), and Schalscha-Ehrenfeld (10).

It appears likely, therefore, that the shoot apices in monocots might possibly have some tendency toward occasional periclinal divisions in the surface layer. A further study of *Chlorogalum* and related plants would help to cast more light on the present rigid concept of "tunica" behavior in angiosperms.

Department of Botany,
University of California, Berkeley,
December, 1943.

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NOTES AND NEWS

Oenothera brachycarpa Gray in Texas. Several collections of this rare and seldom observed *Oenothera* in the subgenus *Megapterium* have been made recently in north central Texas. Citations for these are as follows: breaks along north side of Brazos River, 6.5 miles south of Benjamin, Knox County, May 15, 1941, *Cory 37205* (in flower); Camp Barkeley, Taylor County, April 11, 1943, *Tolstead 6960* (in bud), in red clay soil at west side of camp, July 1, 1943, *Tolstead 7537* (in fruit).

In the description of the subgenus *Megapterium* (North American species of the subgenera *Lavauxia* and *Megapterium* of the genus *Oenothera*. Amer. Jour. Bot. 17: 363. 1930), Dr. Philip A. Munz states, "Seeds as in *Lavauxia*, but in one row in each cell of the capsule, and with corky tubercles." Examination of the capsules of the above cited fruiting specimen of *Oe. brachycarpa* shows the seeds to be arranged in two rows in the capsules as in the subgenus *Lavauxia*. This is also true for *Oe. Wrightii* (regarded as a variety of *Oe. brachycarpa* by some). *Oenothera missouriensis* and its relatives, also members of the subgenus *Megapterium*, do, however, have their seeds arranged in one row in the capsule. V. L. Cory, Texas Agricultural Experiment Station.

The following two items were received too late for review in this issue of Madroño but mention is here made to call them to the attention of our readers. Under the title "The Citrus Industry" by H. J. Webber and L. D. Batchelor (University of California Press) an amazing lot of strictly botanical information is hidden. For instance, Chapter IV by Walter T. Swingle, contains 345 pages entitled "The Botany of Citrus" and comprises a taxonomic monograph of the Aurantioideae of the Rutaceae. Chapter VI deals with the general morphology, histology and physiology of the group and is under the authorship of E. T. Bartholomew and H. S. Reed. The second item is "The Flowering Plants and Ferns of Mount Diablo, California" by Mary L. Bowerman, published by the Gillick Press, Berkeley, California.